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AGRICULTURAL SCIENCE AND THE PEOPLE'S WELFARE[1]

By Dr. E. C. AUCHTER

RESEARCH ADMINISTRATOR, U. S. DEPARTMENT OF AGRICULTURE

I AM going to talk to-day not as a citizen of one country addressing the citizens of other countries, but rather as one scientist talking to other scientists. The concepts and methods of science, including our own agricultural sciences, are still international; they cut deep under the conflict that has now spread over the world. And the faith of science is international; it is that the truth, which science is forever seeking, must ultimately prevail. If it does not prevail now, it is partly because we do not yet know enough of the truth and not enough people are convinced, or even aware, of that which we do know. Meanwhile the scattered fragments of truth that science has discovered can be perverted, and are perverted, to cruel and brutal ends—as when modern technology, a clean-cut product of science, is used to bring whole peoples under the domination of a small group of power-hungry men and to destroy millions of human beings.

But I think there is not a scientist in this audience who would not agree that this *is* a perversion, and who does not feel horror and shame, deep down in his being, that science is so perverted. It is not what we, as agricultural scientists, want. We want to do everything we can to prevent this kind of perversion in the future. We want science to be used to serve the welfare of the people of the world. We know that it is a

[1] Address given at the Second Inter-American Conference of Agriculture, Mexico City, July 6, 1942.

powerful tool to advance human welfare. It can help us to feed, clothe and house ourselves better than the human race as a whole has ever done in the past—and to be healthier and stronger and saner—and to adjust ourselves better to our environment, and to one another as individuals in a society. Science can do these things by helping us to know the truth about the world in which we live—and about ourselves as human beings. "Ye shall know the truth, and the truth shall make you free." The fundamental faith of scientists has never been better expressed than in those simple words, spoken two thousand years ago.

In spite of all the shortcomings of our knowledge, we know enough to-day so that we should be far freer than we are of want and misery, suffering and fear. Our duty as agricultural scientists, then, is threefold: First, to keep on everlastingly seeking for more of the truth, each of us in that field in which our particular work lies; second, to see to it that whatever truths we discover become as widely known as possible; and third, to advance the use of these truths for human well-being.

Sometimes I think we are too modest about that second duty; we hesitate to talk about our discoveries lest it sound like boasting, with the result that they are sometimes neglected or forgotten and, like Mendelism, have to be rediscovered. And we are often too timid about the third duty. We feel that our job is to discover the facts and that the job ends there. Some scientists feel that they are not concerned, as scientists, with how, when or where the facts are applied. The result is that they may be misapplied, even completely distorted—and science gets the blame. I do not say that we can entirely prevent this; I know we can not, because all the scientists in the world are relatively a small handful of people. But we can *help* to prevent it by taking a much stronger, more positive interest in the use made of science by society.

Who should take this interest more than the scientists? After all, it is our work that is used; it plays an enormous part in forming the physical environment and the mental atmosphere of our time. We have the strongest motives for seeing that it is used as universally as possible to create better conditions for human beings. And what is even more important, to make all of us better human beings—wiser, more understanding and more tolerant because we see more of the truth.

This need has now become critically urgent because we are at a turning point in human history. We must build a post-war world that will not be torn apart every few decades by its own inner strains and stresses. We must do this or face a future more destructive than even we of this generation can conceive. The time has come when no scientist can sit any longer in a nice ivory tower, believing that the truths of science by their very nature are something apart from the practical affairs of men. There will be no one even to discover what these truths are if all the ivory towers are blown up by bombs and their occupants are shot by firing squads. That is what we do not intend to permit.

Such thoughts as these are in all our minds; they are a sort of undercurrent in our work in this year 1942. But our immediate concern, of course, is with the everyday problems that face us as agricultural scientists, and my object is to discuss some of the broader aspects of these problems.

Agricultural Science Now Faces a Huge Task

Agricultural science is bound to find itself in a strengthened position as a result of recent events. A short while ago some people felt that it had done its work only too well; it had enabled farmers to increase production to the point where they could no longer dispose of all they produced at a profit. Actually, of course, this was simply another proof of the great power of modern technology. Give it a job to do, like making two blades of wheat grow where none ever grew before or enabling one man to do the labor of five, and it will do the job. Meanwhile, society, including our system of distribution, has to be so ordered that hungry people are able to get the bread—or any other product—that modern technology can produce in abundance. We can not create a powerful tool like technology and then try to throttle it with old-fashioned forms and ideas. We have to use science to advance along the whole front—or else go backward. And once we start going backward, we run a grave risk of returning to something like barbarism.

To-day there is no doubt in any one's mind about the need for science in agriculture. Vast armies have to be fed, clothed, housed and kept healthy. Our allies need enormous quantities of agricultural products. Our industrial workers must be well nourished to produce efficiently. The purchasing power of consumers has increased. Imports of critical commodities have been cut off; we must produce them in the Americas or create substitutes. And meanwhile there is a shortage of agricultural labor in the United States which must in part be made up by technical proficiency. None of these problems can be solved without making full use of all we know about scientific methods—and finding out as much more as we can as quickly as possible.

Nor will the present emphasis on agricultural science end with the end of the war. We shall still have a very big job to do. Much of Europe is starving and in ruins. Asia, Africa, Australia have all suffered in greater or less degree from the blight of war. Immense areas and millions of people will need to be re-

habilitated. To rebuild an exhausted world will necessitate making full use of agricultural science.

At no time have we been faced by so great a challenge. To meet the situation adequately will require the best we have to give in the way of energy and brains. The wisdom and foresight we apply to our work during the war and post-war period of world emergency will be influential not only in having the value of agricultural science fully recognized for a long time to come but in actually shaping the world.

What are some of the things we need to do in conducting our research to meet present needs and lay the foundation for a better future?

The Need for Maximum Efficiency

For some time my own task and that of several of my associates has consisted mainly in following through on a few urgent problems connected with the immediate needs of the war. Getting started on the production of Hevea rubber in South and Central America and of guayule rubber in the Americas and exploring the possibilities of other sources of natural rubber that could be grown in the Western Hemisphere is one of these problems. Working out processes for making synthetic rubber substitutes from agricultural products to help meet the present emergency is another. Still another is the speeding up of new ways of processing and packing foods to save shipping space and still supply the demands of overseas shipment and our armed forces, and to make up for the shortage of tin formerly used in cans and now diverted to military needs. Another has been to develop Western Hemisphere sources of important drugs, fibers and oils which we formerly received from the Orient.

These are jobs that have to be done as quickly as possible. They have meant working under pressure, concentrating scattered research facilities and personnel on a single problem and reducing what we call red tape—the ponderous procedures of government agencies—as much as we can in order to get quick results.

This suggests the first point I want to bring out in connection with agricultural research as a whole. We need to make a critical study of our research procedure to see where we can do more of this kind of thing—cut corners wherever possible, eliminate slow and cumbersome procedures that have grown up as agricultural science became divided into more and more special compartments, and bring people together for quick, common action. We scientists have had our own ways of doing things, very thorough but sometimes rather slow ways, and we were not going to let any one who did not know the necessities of science interfere with them. There are, of course, many things that can not be speeded up in scientific research; but I am convinced that there are also places where we can rid ourselves of excess baggage and strip down to a more clean-cut basis that will enable us to proceed faster and more efficiently. This is the time to do it. We can not afford to be slow in meeting the problems of human welfare that face us all with increasing urgency.

We Should Lead as Well as Follow

There is a second point of quite an opposite kind, however, in connection with this war work. We must beware of the temporary pressure of public opinion—which operates very strongly on a public research agency—to drop certain projects or certain lines of work that seem to us very worth while. I am reminded of this particularly in connection with the work on natural rubber. The Bureau of Plant Industry in our Department of Agriculture has been studying the sources of natural rubber for the Western Hemisphere for many years. As far back as 1921 our scientists foresaw the situation we have to-day. "Suppose," they said in effect, "we were to be cut off from the supplies of rubber in the Far East; we ought to be ready to produce it nearer to our own doorstep. Otherwise we might find ourselves in a very serious situation at a critical time."

This caution undoubtedly seemed far-fetched to a good many people, and there were unquestionably sound economic arguments against developing natural rubber here. Perhaps the scientists seemed like dreamy, impractical fellows. Nevertheless, they kept on studying rubber-bearing plants, doing what work they could, even if it was only a modest amount. It was this far-sightedness that has enabled us to go ahead rapidly with the present Hevea project in South America and the guayule project in the Americas. These "impractical" scientists laid the groundwork for what we are doing to-day.

The point is that the scientist is often the shrewdest judge of what needs to be done in his own field. In this case, even though there was no immediate need to develop sources of natural rubber in our part of the world, he knew how long it takes to breed and evaluate rubber plants, and find out where they will grow best, and work out the best methods of growing them in a new environment. "Let us be prepared," he said, "at least to the extent of knowing how to do the job if we have to." We can see now that he was right.

The lesson, so far as agricultural research in general is concerned, is that the research agency should carry along certain projects when it is convinced, after rigid self-examination, that they have an insurance value for the future, even though they may not have popular appeal at the time. The research worker must do more than follow the trends of current events; he also has

a responsibility as a leader who looks ahead. Where scientific work is closely and directly tied up with the public welfare, as ours is, this responsibility is especially great. If we exercise it wisely, we can be sure of public approval in the long run.

The Need for Freedom of Inquiry

Closely related to this point—the need to carry along certain projects whether or not they seem to have immediate value—is the question of carrying on basic research.

Many people think of basic research as purely theoretical; they are unable to see, for instance, that it has any practical bearing on farm problems. "Why spend time and money on it," they ask, "especially in a critical period like this?" To the scientist, the answer is simple: The whole progress of science depends on filling in the gaps in our knowledge of the nature of things. To the layman, however, it is not so obvious that much of the structure of modern science, with its vast number of practical applications in our daily lives, is based on a comparatively few fundamental discoveries.

In the case of basic research, we can seldom tell in advance what these practical applications will be; we simply know that we are on the trail of a fact which explains something not previously understood. But once the fact is established, the practical applications —sometimes very surprising ones—are likely to turn up in abundance. Three cases in our own work occur to me because they are very recent.

It has been known for a long time, of course, that plants respond among other things to temperature and also to intensity of light. A few years ago it was discovered that they also respond to length of day. After this fundamental discovery was made, a good deal of experimental work was carried on to find out the nature of the responses, and many important facts were uncovered, the upshot of which is that the growth, flowering and fruiting characteristics of many plants —including many of economic importance in our agriculture—vary with variations in the length of the light period to which they are exposed.

Originally this may have seemed like an interesting botanical fact not of great practical importance. But note some of the developments to which it has led.

Instead of expensive and lengthy field experiments, we can carry out comparatively inexpensive experiments in a greenhouse, under controlled light and other conditions, which show the range of adaptability of various kinds of plants; and on the basis of these experiments we can predict with considerable certainty what plants will do well in a given locality. If certain varieties of plants prove not to be well adapted to the day length and other conditions there, we can breed varieties of high quality and great uniformity that will be adapted.

We used to be almost entirely dependent on Europe for our supply of sugar-beet seed. By determining the rather exacting temperature requirements for seed production by sugar beets, we were able to find localities in our own country where large crops of seed could be produced. In fact, we now save a great deal of time and labor by growing the beets for seed as a winter annual, the cycle being much like that of winter wheat. Not only are we independent of European sources, but the seed we produce is better adapted to our conditions than that from Europe because it has been bred for resistance to the plant diseases prevailing in our country. In the breeding work, light exposure as well as temperature is manipulated in the greenhouse so that we can bring our selections to the seeding stage in the minimum time.

There are many other practical applications of this essentially *botanical* discovery about the nature of plants. Onion varieties can be found or bred that will produce bulbs in a short-day region, others in a long-day region; likewise strawberries that will fruit abundantly in our long-day northern areas, others in the short days of our South. The same thing is true of other agricultural crops. Florists can hasten or delay the flowering of plants simply by controlling the light period in the greenhouse. And so on. All this means a better adaptation of production to the needs of both producers and consumers in a given area.

If I had more time, I would like to go into this matter in greater detail. For example, it was found recently that a few minutes of exposure to light near the middle of the dark period gave results similar to those from a full exposure. Grafting a single leaf of an Agate soybean, which blooms readily under long-day conditions, onto a Biloxi soybean, which requires a short day, enabled the Biloxi also to bloom under long-day conditions. Such facts as these open up fascinating fields for new explorations in plant chemistry and physiology.

The discovery of growth-regulating substances, generally called plant hormones, is another example of basic research that is now giving practical results. We carried this work along quietly for several years, treating various parts of plants—roots, stems, buds and flowers—with many different substances, some of which had marked effects of great theoretical interest; in some cases the natural behavior of the plant was completely altered. In the course of these experiments it was found that apple trees treated with a very dilute hormone solution would hold their fruit without dropping it far beyond the normal period. As a result, hormone spraying of apples is already becoming a standard orchard practice that promises to be of

immense value to producers in preventing the dropping of fruit before it has reached good size and color. This single application should save far more than all the money spent on all our hormone research. Yet it was not even dreamed of in the beginning of the research work; in fact, it was simply one of several by-products of the research job. I think we can say confidently that there will be many other practical applications of this work. One of them, already of considerable value, is the use of hormones to stimulate root development in cuttings of plants that ordinarily root with great reluctance. Another, so far tried only experimentally, is the dusting of blossoms to obtain fruit of better quality with such plants as the tomato.

The third example I want to mention briefly is waxy corn. In the course of research on the genetics of corn, a plant was developed with a peculiar waxy quality in the starch of the endosperm. It was of no practical use whatever, but because of its theoretical interest it was not discarded but carried along by the breeders. Now this curious corn promises to be of great value as a substitute for tapioca starch, the supplies of which have been cut off by the war.

The examples I have used have all come from the plant field, but similar ones could be given in practically every other field of agricultural science. Time permits mentioning only a few cases in which basic research has played a part in one way or another, though not always in as clean-cut a fashion as in the illustrations already mentioned.

In the animal-disease field, there is the discovery of phenothiazine as an anthelmintic. One of the remarkable things about phenothiazine is that it is effective for a considerable range of internal parasites in various classes of animals, whereas most anthelmintics are quite specific and limited in their usefulness. In addition, it can be administered more easily and conveniently than most anthelmintics. All in all, phenothiazine promises to be one of the most valuable aids we have in combating worm parasites, which as you know are a major enemy of livestock production. As part of the background of this development there were years of patient work studying the effects of parasites in the animal organism and testing many different kinds of drugs for their anthelmintic value.

Similarly, in our modern insect control work, there is a background of studies in the life histories of insects to determine at what points each one is most vulnerable to attack, as well as detailed studies of the physiology and functioning of the insect organism, especially in relation to the effects of various poisons.

In animal breeding, we are engaged in a major project to increase the production of our dairy herds by the wide-spread use of tested and proved sires. This is an undertaking of very large scope, and it would never have been started if our breeders had not been convinced, on the basis of a long, careful study of the fundamental genetic problems involved, that it could be successfully done—and that it would result in very worth-while economies in milk production.

Fundamental researches in the genesis of soils led to the development of the principle of ionic exchange or "base exchange." The practical results have been numerous and far reaching. We can now apply lime to acid soils accurately according to the needs of different crops and combinations of crops. Even more important, we can control irrigation much better. The formation of puddled alkali soils can be prevented, and alkali soils can be reclaimed through chemical treatments and the control of irrigation water and drainage.

In the field of human nutrition, there have of course been many interesting developments in recent years. One of them of particular importance to all of us in agriculture is based on what was essentially a piece of basic research in the dietary habits of large numbers of individuals, families and economic groups. Out of this has come a method of determining the nutritional status of whole segments of a population. This is immensely valuable not only in production planning but also in what I might call the statesmanship of human well-being. Before we can raise the nutritional level of a population or a group, we must know where they stand and what improvements need to be made—and this information has not hitherto been available.

In all these cases, either basic research precedes the practical applications of science, or a certain amount of this kind of research is found to be necessary somewhere along the line to clear up obscurities that block further progress. As public service agencies, our agricultural research institutions exist primarily to help agriculture solve practical problems. But the point I am making is that in research there is no single road to practical results. If we keep our eyes constantly and exclusively on what seem to be immediate needs, we miss some of the richest fruits of scientific work—the fruits that grow from the discovery of important fundamental facts.

This is not to say that we do not need to use good judgment in the choosing of research projects in a given program. We need to use the best possible judgment. But in the last analysis, it should be the judgment of scientists. This is the essence of scientific freedom or freedom of inquiry.

Perhaps that is what it gets down to—freedom of inquiry. This freedom is denied whenever an effort is made to use science solely for the support and aggrandizement of a special group. In the long run this is a terrible mistake. Freedom to explore all kinds

of facts wherever they may lead is absolutely necessary if science is to advance human welfare. It is a freedom worth fighting for.

The emphasis I have given to basic research and freedom of inquiry does not mean that we should pay any less attention than we do to homely experimentation directed toward solving everyday problems. On the contrary, most of our time will necessarily be spent on this kind of work. After the basic facts are discovered, there is always an immense amount of what might be called best-way research to be done. What is the best way to prune fruit trees? What is the best way to meet the mineral requirements of livestock? What is the best way to cook vegetables so they will retain their vitamins? The number of such problems is endless, especially since in every case the best way varies under different conditions of cost, available equipment, environment and final result desired. To determine all these best ways means carefully controlled, systematic experimentation, demanding much patience and frequently a great deal of ingenuity.

Coordination is Needed

The next point I want to emphasize is the need for coordination, briefly touched on earlier in these remarks.

I don't know how it may be here in Mexico City, but in the city of Washington, this period might well be called the Age of Getting Together. I have never seen so many gatherings of different groups to discuss urgent needs and decide on combined action to meet them. They are so numerous, in fact, that I sometimes feel as though I were not doing anything else but attend conferences.

This has its drawbacks, but it is a sign of the times. In a time of common peril, separate groups tend to pull together and act as one group to achieve a single aim.

We in the agricultural sciences are feeling this influence very strongly. It is a good influence. I hope and believe that we are at the beginning of a new time of closer cooperation and better integrated planning. Many of us have given lip service to this principle in the past, but we have carried it out only in a partial, half-hearted way. From now on we will be compelled to carry it out much more vigorously and wholeheartedly if we are to solve the pressing problems of the public welfare.

In the ordinary course of events, an agricultural problem might be tackled something like this: Perhaps the chemists see the problem first and approach it from the chemical standpoint. They work along for a couple of years and then find that there is a bacteriological aspect. The bacteriologists work on this for a few years, and discover that there is an entomological problem mixed up in it. After the entomologists have worked for a while, some one finds that the home economists should be brought in. Meanwhile each group works strictly along its own bureau or departmental lines, jealously guarding its bureaucratic prerogatives and fearful that the others will trespass on its ground. Perhaps at the end of ten years, the problem is finally solved.

Why not get the chemists, the bacteriologists, the entomologists and the home economists all together in the beginning and have them working simultaneously on parallel aspects of the problem, instead of end to end, separately and in sequence? In that way the job might be done in two or three years instead of ten. This is what we are doing now with more and more of our problems. The method is not new, of course, but its use is being accelerated by the conditions we all face to-day. We still have much to learn about this kind of integration, but as it is extended over larger areas of our work, the possibilities seem to me stimulating and inspiring.

I should like to mention briefly a research project that may serve as an example of the sort of coordination I have in mind.

As part of the background of this project, three facts are especially important. (1) Most agricultural research with crops has had as its ultimate object the production of the greatest quantity of a given product of a high market quality from a given acreage. (2) Recent work in the field of nutrition, however, has developed hitherto unknown facts which give us a new understanding of nutritional quality and its immense importance for human well-being. (3) There is ample evidence that food and feed plants grown on soils deficient in certain minerals—iron, copper, manganese, cobalt, phosphorus, for example—fail to supply enough of the deficient minerals to maintain good health. Human beings living on these foods suffer from serious physical disabilities; animals may actually die by the thousands.

These facts raise important questions: To what extent would it be possible for us to improve and insure high nutritional quality in food and feed plants as an objective in agricultural production, in addition to our older standard objectives of quantity and market quality? And how can health and human welfare be improved by adopting such objectives?

Recently, in cooperation with many states, we established a nutrition laboratory on the campus of Cornell University, in the State of New York, to study this question.

As you will readily see, it breaks down into a good many different parts because there are many things that may affect the nutritional quality of both crop and livestock products. For instance:

What does climate have to do with the vitamin or mineral content or other nutritional factors in the case of such farm products as vegetables, fruits and grains? What variations are due to differences in soil? What effects do soil amendments, such as fertilizers, have? What are the effects of other agronomic practices besides the use of fertilizers? Do different varieties of the same plant vary significantly in nutritional quality? If so, to what are the differences due—and would it not be possible to breed plants with superior nutritional value?

We have hardly more than begun this work, but so far I think we can say definitely that it will be possible to breed some plants at least that will have uniformly superior nutritional quality so far as their content of vitamins and minerals is concerned. That is not the point here, however. The point is that this project necessarily involves simultaneous work by scientists in many fields. We have brought into the picture outstanding experts in human and animal nutrition, in soils, in plant breeding, in plant physiology, in home economics and in public health problems. Each has vital contributions to make on different aspects of the whole project. As a result, I believe that we shall avoid the common danger of going too far in one direction while missing something of great importance in some other direction. The whole project, to my mind, is an excellent example of cooperative research focused on a common objective that not only has great scientific interest but should make a real contribution to human welfare through better nutrition.

We Need Social Awareness

The final point, which I wish to emphasize again, is the need for research workers to be very much aware of the relation of their work to the problems of human welfare.

We have perhaps taken this too much for granted. Science has accomplished so much in the modern world—its achievements are so evident all around us in the form of new products and new modes of communication, transportation, manufacturing, and so on—that we assume that of course it contributes to human welfare.

Yet we have been faced by the stark facts of poverty and unemployment in the midst of plenty—ignorance in an age of enlightenment—and finally, total war, meaning total destruction, in an age supposed to be dominated by science, which is essentially a builder and not a destroyer.

Can we, as scientists, look at the world to-day and say we have done all we could to make our work contribute to human welfare? Have we not been rather naive in assuming that our job was to do the particular piece of research in front of us, irrespective of how the results were used?

A discussion of these questions would take me very far afield. I am raising them simply to suggest that it is part of our business as agricultural scientists to try to understand and as far as possible anticipate human needs—social and economic needs—in our work. To take an immediately pressing example—what is the world going to be like after this war? How can the enormous productiveness of science be put to work to make it a better world to live in than the one before the war? How can we direct our work as scientists to prevent wars and to create peace, plenty and opportunity for far more of the world's people? Those are the kinds of problems we must face in our thinking and planning. There is no question but that the viewpoint and method of science can be a powerful factor in solving them.

The agricultural research institutions of the Americas constitute, in the aggregate, a very large body of scientific facilities and skilled personnel. Our big job in the years immediately ahead is to use our combined power and vision for the welfare of humanity—and when I say our, I mean those of us who work in the natural sciences as well as the economists. If we make this the unswerving intent and purpose behind our work as agricultural scientists, I am sure we shall find the means to contribute a great deal to a brighter future for mankind.

SCIENTIFIC EVENTS

RECENT DEATHS

Dr. Hector Russell Carveth, electrochemist of Niagara Falls, N. Y., died on September 7 of injuries sustained as the result of the explosion of a cement tank. He was sixty-nine years old.

Dr. John Arthur Wilson, consulting chemist, New York City, president of John Arthur Wilson, Inc., died on September 17, at the age of fifty-two years.

Daniel A. Lehman, professor emeritus of mathematics and astronomy of Goshen College, died on September 8, at the age of eighty-two years. He had been a professor at the college since 1906.

Sir John Macpherson, emeritus professor of psychiatry in the University of Sydney, died in England on August 14 in his eighty-fourth year.

Nature reports the death at the age of seventy-three years of Dr. Kurt Brandenburg, professor of special

pathology and therapy at the University of Berlin, editor of the *Medizinische Klinik;* and of Sir Montagu Sharpe, K.C., the well-known ornithologist, chairman of the Council of the Royal Society for the Protection of Birds, who died on August 23, at the age of eighty-five years.

THE AID OF SCIENCE IN PRODUCTION IN GREAT BRITAIN

IN order to ensure that the fullest use is made of scientific and technical resources in the field of production, the British Minister of Production, according to *The Times,* London, has appointed W. A. Stanier, chief mechanical engineer to the London Midland and Scottish Railway; Dr. T. R. Merton, treasurer of the Royal Society, and Dr. I. M. Heilbron, professor of organic chemistry, Imperial College of Science and Technology, to his staff in the capacity of full-time scientific advisers. The official statement reads:

> The field of activity of these advisers will be co-extensive with the responsibility of the Minister of Production. They will keep in close touch with the scientific advisers of the Service and Supply Departments, and will be available to assist the departmental organizations of scientific research and technical development. They will not supersede the departmental organizations, which will, for instance, continue to be responsible for the examination of new inventions and technical suggestions in their own fields.
>
> They will be responsible to the Minister of Production, but will work under the immediate supervision of the Lord Privy Seal, acting on his behalf.
>
> These appointments have been made with a view to completing the existing organization for scientific research and development which has been carefully built up over a number of years and operated with outstanding efficiency.
>
> The Government has reviewed the whole position in the light of recent representations, and has decided that the creation of the post of Minister of Production affords the opportunity for this further measure of coordination which the Government believes will be to the national advantage.

THE SECRETARY OF THE ZOOLOGICAL SOCIETY OF LONDON

ACCORDING to *The Times,* London, the secretary of the Zoological Society of London, Dr. Julian S. Huxley, has written to H. G. Maurice, vice-president and chairman of the council, resigning the secretaryship of the society and membership of the council. His letter is as follows: "I am writing to ask you to transmit to council my resignation as secretary to the society and member of council. I am sorry to have to do this, but as I had associated myself with the informal committee, and as the fellows have now voted against their nominees, I feel that no other course is open to me. Apart from this, I regret that there no longer exists that measure of mutual confidence and general agreement between myself and council which would warrant my continuing to hold the post of secretary. I am, of course, taking steps to find alternative accommodation, and shall vacate the official flat as soon as I have done so. In view of the misapprehensions which still exist concerning my own position, I am sending a copy of this letter to the press."

Dr. Huxley's resignation was received by the council of the society at their meeting on August 26, and at the meeting of fellows which followed, Mr. Maurice expressed his regret that "a man of such brilliant parts as Dr. Huxley should be of such restless genius as not really to fit in with the routine drudgery of an institution of this character." The council's personal relations with Dr. Huxley had always been very friendly.

Mr. Maurice announced that a resolution handed in at the annual general meeting advocating the establishment of a committee of council members and fellows to inquire into the administration of the society had been accepted by the council. This committee would investigate the suggestion that the society's original charter, in existence since 1829, was in need of reform. Members of the committee would be appointed at the next council meeting in a month's time.

MEDICAL AID TO CHINA

HELEN KENNEDY STEVENS, the executive director of the American Bureau for Medical Aid to China, writes to SCIENCE as follows:

> Apropos of Egbert H. Walker's suggestion in the July 17 issue that American scientists should save scientific publications for the future use of Chinese scientists whose own libraries have been destroyed, may I inform your readers that the American Bureau for Medical Aid to China, one of the participating agencies of United China Relief, for some time has been collecting text-books and journals for shipment to the Emergency Medical Service Training Schools in China and other institutions desperately in need of such literature. American physicians and institutions have been most generous in donating texts and journals which those in charge of Chinese schools and hospitals have asked us to obtain.
>
> Unfortunately, now that the port of Rangoon and the Burma Road have been cut off, and there are such heavy demands upon the transport routes from India, it is inadvisable for us to continue to send books, but we are sending texts and charts on micro-film, which go by air mail and may reach China less than a month after their publication here. The film texts have the added advantage that, once arrived in China, they can be passed around from school to school.
>
> That the Chinese have made good use of this oppor-

tunity to keep up with the latest scientific developments is indicated by the fact that sulfaguanadine was used in the Chinese Army for dysentery before its use had become general in America.

GRADUATE COURSE ON INDUSTRIAL HEALTH AND MEDICINE IN WAR TIME AT YALE UNIVERSITY

As announced by Dean Francis G. Blake, the Yale School of Medicine will offer a graduate course designed primarily for physicians of Connecticut on "Industrial Health and Medicine in War Time." The program will consist of twelve afternoons devoted to lectures and seminars by physicians and specialists nationally prominent in the field of industrial medicine. These meetings will be held on Wednesdays from October 7 through December 23. The course is under the joint direction of Dr. William T. Salter, professor of pharmacology; Dr. John R. Paul, professor of preventive medicine, and Dr. C.-E. A. Winslow, chairman of the Department of Public Health. Dr. Winslow said, in commenting on the course:

The growing importance of the field of industrial hygiene and industrial medicine has been evident in the country in general, and particularly in the industrial state of Connecticut. The demands for industrial physicians will increase, and the type of service that they will be asked to perform will be more exacting during the next few years.

In these days, family life is centering more and more about industry. Therefore industrial medicine will soon be required as a new specialty, and the doctor who can help both labor and management in the maintenance of a healthy working force will be more and more important.

The men behind the guns constitute our first line of defense; but they are helpless without a second line—the men and the women who make the guns. The fate of our country depends on both these groups. The men in service are rigorously selected and protected by every device known to medical science. The workers in war industries have often in the past been left to shift for themselves.

Many urgent and complicated problems must be met by industrial physicians in these times. For example, women are replacing them in various types of defense work. What will be the physical result? How far can average women be adapted to fatiguing and trying tasks? Likewise, defense plants may be subjected to concentrated attack by raiders or saboteurs. In planning for such possible emergencies the industrial physician must be prepared to play an important part. Furthermore, in order to maintain maximum output of war materials, the general nutrition of workers must be maintained. These are but a few of the intricate questions which the doctor must assist in solving.

Sickness and accidents among industrial workers cause the loss of 234,000,000 man-days of work a year, according to one careful survey. If we assume 300 work days per man a year, this means that on a given day more than 700,000 industrial workers are incapacitated. It is estimated that half of this absenteeism could be eliminated by preventive measures and adequate medical care.

This is why it is so vitally important that industrial physicians should be provided to supervise the health of the workers in our war industries. Industrial medicine is a complex and exacting specialty requiring special training and experience.

The lecturers and their topics are as follows:

October 7. Toxicity and Potential Dangers of Aliphatic and Aromatic Hydrocarbons, Dr. W. F. Von Oettingen, U. S. Public Health Service.

October 14. Dusts and Silicosis, Dr. Leroy U. Gardner, Saranac Laboratory.

October 21. Toxicity and Potential Dangers of Metals, Dr. Robert A. Kehoe, University of Cincinnati.

October 28. Toxicity and Potential Dangers of Chlorinated Hydrocarbons, Dr. Alice Hamilton.

The Use of Hazardous Materials in Industry and Methods for Atmospheric Determinations, A. L. Coleman, Connecticut State Department of Health.

November 4. Dermatoses in War Industries, Dr. Louis Schwartz, U. S. Public Health Service.

November 11. Factory Epidemiology, Lieutenant-Colonel A. J. Lanza, M.C., U. S. Army.

Control of Industrial Accidents, Everett W. Martin, Liberty Mutual Insurance Co.

November 18. Nutritional Problems in Industry, Dr. Robert S. Goodhart, Office of Defense Health and Welfare.

Practical Problems of Nutrition, Dr. George R. Cowgill, Yale School of Medicine.

November 25. The Influence of Physical Factors upon Fatigue of the Industrial Worker, Lieutenant-Colonel D. B. Dill, Air Corps, U. S. Army.

Engineering Control of Plant Health Hazards, B. F. Postman, Connecticut State Department of Health.

December 2. Extra-Mural Factors in Industrial Health, Dr. C.-E. A. Winslow, Yale School of Medicine.

Organization of Health Services in Industry, Dr. M. I. Hall, General Motors Corporation.

December 9. New War-Time Problems in Industry, J. J. Bloomfield, U. S. Public Health Service.

Employment of the Physically Handicapped Worker, E. R. Chester, Connecticut State Department of Education.

December 16. Mental Hygiene in Industry, Dr. Lydia Giberson, Metropolitan Life Insurance Company.

Medico-Legal Problems in Industrial Medicine, Dr. Louis Sachs, New Haven, Connecticut State Workmen's Compensation Commission.

December 23. Opportunities and Responsibilities of the Medical Profession in Industry, Dr. Arthur B. Landry, Hartford, Committee on Industrial Health, Connecticut State Medical Society.

Availability of Public Health Services to Industrial Physicians, Dr. A. S. Gray, Connecticut State Department of Health.

REGISTRATION IN THE NATIONAL ROSTER

DR. J. S. NICHOLAS, of Yale University, National Research Council representative on the National Roster of Scientific and Professional Personnel, has sent to SCIENCE further results of its questionnaire, giving registration as of September 2.

	Number mailed	*Number returned*
Agronomy and soil sciences		1,105
Anatomy	835	653
Animal husbandry		719
Bacteriology	3,763	2,243
Biology	80	25
Botany	2,200	1,449
Chemistry	100,741	68,918
Dairy science		1,196
Fish and wildlife research		318
Forestry and range management	5,463	4,147
Genetics	2,084	1,073
Geology	7,599	4,032
Geophysics	4,370	2,057
Horticulture		764
Mathematics	12,092	6,926
Mycology		19
Nutrition	513	301
Pharmacology	354	229
Physics and astronomy	13,712	9,831
Physiology	1,045	694
Plant pathology		909
Psychiatry	1,115	830
Tropical medicine	912	461
Veterinary bacteriology		149
Veterinary science		5,310
Zoology and entomology	7,916	4,639

In the previous month's report on the registration in the National Roster (SCIENCE, 96: 2486, 175), due to the system of main headings employed, the agricultural fields were not listed separately. They are still partly covered by other groups, but this is due to individual choice of the society members in filing their questionnaires. In recirculations which are now taking place as speedily as possible, it is hoped that each individual will indicate his main field of endeavor and request the technical check list most applicable to his field. Accuracy in personal evaluation is a necessity for the correction of roster figures. The cooperation of scientific men is solicited.

SCIENTIFIC NOTES AND NEWS

CHARLES EDWARD WILSON, president of the General Electric Company, has been named a vice-chairman of the War Production Board. Gerard Swope, president of the General Electric Company from 1922 to 1939, now director and honorary president, will resume the presidency.

THE Caldwell Medal of the American Roentgen Ray Society for distinguished work in cancer research was presented on September 15 at the New York meeting to Dr. Cornelius Packard Rhoads, director of the Memorial Hospital for the Treatment of Cancer in New York City.

THE Borden achievement award for distinguished contributions to poultry science has been given to Vigfus S. Asmundsen, associate professor of poultry husbandry at the University of California. The award, which is for accumulated research over a period of seven years, rather than for a single piece of work, carries with it a gold medal and $1,000. Ordinarily the medal is conferred at the annual meeting of the Poultry Science Association, but since that meeting has been cancelled this year, the presentation has been arranged by Dean C. B. Hutchison, of the College of Agriculture at Davis. A representative of the Borden Milk Company will present the medal, at a time to be set later.

DR. KARL F. MEYER, director of the Hooper Foundation of the University of California, San Francisco, was chosen president-elect at the Seattle meeting of the Western Branch of the American Public Health Association. He succeeds Dr. Donald G. Evans, Seattle, who was installed as president.

DAVID T. POTTINGER, associate director of the Harvard University Press, has been elected an honorary vice-president of the American Institute of Graphic Arts.

OFFICERS of the American Psychological Association have been elected as follows: *President,* John E. Anderson; *Council of Directors,* Sidney L. Pressey, Robert H. Seashore; *Treasurer and Business Manager of Publicity,* Willard L. Valentine; *Nominees for Representatives on the National Research Council,* John E. Anderson, Arthur G. Bills, Hadley Cantril; *Representative on the Social Science Research Council,* Walter S. Hunter.

LIEUTENANT COMMANDER C. M. LOUTTIT, U.S.N.R., was elected president of the American Association for Applied Psychology on September 4 at the sixth annual meeting held in New York City. Dr. Alice I. Bryan, Columbia University, was made executive secretary.

PAUL M. DUNN, who has been since 1935 head of the work in forestry at Utah State College, has been elected dean of the School of Forestry of Oregon State College. He succeeds Acting Dean Earl G. Mason, who has served since the retirement of the

former dean and president, Dr. G. W. Peavy. Dr. Mason will continue his work as professor of forestry.

DR. VERNON I. CHEADLE, assistant professor of botany at Rhode Island State College, has been promoted to a professorship and has been made head of the department. He succeeds Dr. H. W. Browning, who has been made vice-president of the college and dean of the School of Science and Business.

DR. THOMAS D. DUBLIN, epidemiologist in the New York State Department of Health, has been appointed head of the department of preventive medicine and community health at the Long Island College of Medicine.

DR. HERBERT F. TRAUT, of Cornell University Medical College, has been appointed professor of gynecology and obstetrics at the University of California Medical College, San Francisco.

DR. PABLO MORALES-OTERO, acting director of the School of Tropical Medicine, University of Puerto Rico, has been appointed director. He succeeds Dr. George W. Bachman, who has been director since 1931.

DR. AURA EDWARD SEVERINGHAUS has been appointed assistant dean of the College of Physicians and Surgeons of Columbia University.

DR. H. J. MULLER, research associate, has been appointed for the duration of the war professor in the department of biology of Amherst College.

DR. S. BERNARD WORTIS, associate professor of neurology, has been appointed the first Lucius N. Littauer professor of psychiatry at the New York University College of Medicine and visiting neuropsychiatrist in charge of the Psychiatric Division of Bellevue Hospital. He succeeds Dr. Karl Bowman, who resigned last year. The chair of psychiatry has been named for Lucius N. Littauer, the philanthropist, who established in 1941 a fund of nearly a quarter of a million dollars "for research in psychiatry, neurology and related fields, in order to increase and diffuse knowledge of the biological and other factors which influence thought and conduct; and thereby to prevent and correct abnormal human behavior through clinical and experimental approaches."

JAMES W. SCHADE, until December, 1941, research director at the B. F. Goodrich Rubber Company, has joined the staff of the University of Akron (Ohio) to give a special lecture course in rubber technology, in cooperation with the Goodrich, Firestone and Goodyear Rubber Companies. The lectures will be especially designed for young men coming into the industry, aiming to give them a broad understanding of the entire rubber production field.

SIR HENRY DALE, president of the Royal Society, London, who was recently appointed a member of the governing body of the Lister Institute of Preventive Medicine, has been elected by the board as its chairman.

DR. LOUIS B. FLEXNER, of the department of anatomy of the Johns Hopkins University School of Medicine, has leave of absence to enable him to serve as aide to the committee on aviation medicine of the National Research Council.

DR. DOROTHY BIRD NYSWANDER, of the New York City Department of Health, has been named regional supervisor of War Public Service Projects of the Federal Works Agency.

DR. HENRY W. CAVE, who has been serving as state chairman for physicians in New York of the Procurement and Assignment Service, has been appointed chairman of the Second Corps Area, which embraces the states of New York, New Jersey and Delaware. Dr. Joe R. Clemmons will succeed Dr. Cave as the state chairman for physicians in New York. Dr. Donald S. Childs is vice-chairman for physicians in the upstate area.

DR. LOYAL DAVIS, head of the surgical department of Northwestern University Medical School, Chicago, and editor of *Surgery, Gynecology and Obstetrics*, has been commissioned a lieutenant colonel in the U. S. Army Medical Department and assigned to duty as consultant in neurosurgery in the Surgeon General's Office, Washington, D. C.

A. TURNER WELLS, secretary and director of the American Optical Company, has been commissioned a captain in the Medical Department, Service of Supplies, and is attached to the Surgeon General's office in Washington. He assisted in designing the mobile optical unit recently accepted by the Government. Through the unit, men in the armed forces will be able to obtain optical repairs near the front.

DR. RAYMUND L. ZWEMER, of the department of anatomy of the College of Physicians and Surgeons, Columbia University, has recently returned from three months spent in research and teaching at the Institute of Endocrinology, Montevideo, Uruguay. He was sent by the Committee for Inter-American Artistic and Intellectual Relations of the Office of the coordinator for Inter-American Affairs at the request of Dr. Mussio-Fournier, Uruguayan Minister of Public Health. On the return trip, Dr. Zwemer visited various universities and gave lectures in Argentina, Paraguay and Brazil. One of the lectures in Rio de Janeiro was given before five hundred military surgeons at the Ministry of War, just after war was declared by Brazil on the Axis.

DR. W. C. LOWDERMILK, assistant chief of the Soil Conservation Service of the U. S. Department of

Agriculture, according to Science Service, has been placed at the head of a scientific mission at the request of the Chinese Government. Dr. T. Dykstra, plant breeder in corn and potatoes, is accompanying Dr. Lowdermilk, and later an animal breeder and hydraulic engineers will join them in Chungking. The need for food in China has been increased by the 60,000,000 refugees who fled inland as a result of the Japanese invasion. Cultivation was pushed up the slopes of the hills and mountains. Crops such as potatoes and corn were more generally grown. Dr. Lowdermilk and his colleagues will cooperate in setting up a soil conservation service which will be a permanent organization for the purpose of assuring ample food production in coming years. The group will work closely with Dr. D. Y. Lin, of the Chinese Ministry of Agriculture in Chungking.

THE Research Council on Problems of Alcohol, an associated society of the American Association for the Advancement of Science, will meet at one o'clock on Monday, September 28, in the Commodore Hotel, New York.

THE annual meeting of the New York State Geographical Association, which had been planned for Oswego on November 7, has been cancelled.

DR. ROBERT H. SEASHORE, chairman of the Public Relations Committee of the American Psychological Association, writes: "It may be of interest to other societies to note that due to the increase of defense transportation, the regular five-day meetings of the association scheduled for the same week at Harvard University were cancelled and a skeleton one-day business meeting was held in New York City in order to conserve transportation facilities. Since the reduced meeting had an attendance of only ten per cent., as compared with normal meetings, it can be seen that there was a very great saving in transportation. A similar skeleton meeting to administer the business officers of the association will be held in Chicago during the first week in September of next year unless other emergencies interfere. The association is continuing its Office of Psychological Personnel under the auspices of the National Research Council in order to facilitate the placement of psychologists in various military and other governmental offices."

IT is reported that at a special meeting in Chicago on September 17, the American Medical Association decided to cancel its next annual meeting. In place of this meeting, which is usually attended by from 6,000 to 10,000 physicians, the house of delegates, the board of trustees, the scientific councils and officers will meet in Chicago next June to deal with the essential business of the association and the war-time problems of the medical profession. Cancellation of the meeting, which had been scheduled for San Francisco next June, marks the first time since the Civil War that the association has postponed one of its annual sessions. The trustees, it is reported, also took into account the strain that such a large delegation in San Francisco would place on war-burdened transportation facilities.

THE council of the Royal Horticultural Society reports that for its general senior examination held in prisoner of war camps in Germany it has received the papers from nine candidates, and that five of these candidates have passed the examination.

DISCUSSION

THE NEW YORK MATHEMATICS TABLES PROJECT

MATHEMATICIANS and many other scientific workers can become enthusiastic over certain expenditures by the Government's Work Projects Administration (WPA) which have led to the publication and calculation of many important mathematical tables, sold very cheaply when published. The large bound volume of "Natural Sines and Cosines to Eight Decimal Places," for every second of arc, recently issued as Special Publication No. 231 of the U. S. Coast and Geodetic Survey ($1.75), was prepared in 1941–42 as a WPA project at Philadelphia, under the sponsorship of the Survey. The personnel of this Philadelphia group was also mainly responsible for the 8 large volumes of tables ($2.25 each) in Hydrographic Office, Publication No. 214, 1941, "Tables of Computed Altitude and Azimuth, Latitudes 0° to 79° Inclusive." Their other work was much less mathematical. But during the past four and one-half years the Mathematical Tables Project of the WPA in New York City has achieved an extraordinary body of calculation and publication. A somewhat detailed account of this would seem to be timely and likely to interest many people. It is hoped that such publicity may contribute to action serving to make the project's activities still more potent. Further reference to such action is made towards the close of this article.

The actual organization of the New York Project began in January, 1938, under the sponsorship of Dr. Lyman J. Briggs, director of the U. S. Bureau of Standards, who determines the Project's policies and activities, and oversees the distribution of its publications. It is indeed fortunate that representations to

the government on behalf of the Project should be made by a man of such eminence, fully conversant with the scientific implications of all that the Project undertakes. The technical supervision of the Project was placed in the hands of Dr. Arnold N. Lowan, who has not only served the Project with notable ability, but has also in various ways assisted many inquiring scientists with very useful information.

Those setting up the Project were given detailed instructions as to the persons whom they might employ. It was not long before a large corps of computers and computing machines had been assembled, and the demands for new tables were constantly increasing.

In that extraordinary laboratory at 70 Columbus Avenue in New York City, there are now 250 computers working in two shifts from 9:00 o'clock A.M. to 5:00 P.M., and from 5:00 P.M. till midnight, on five days of the week. The two shifts were necessary in order fully to utilize the following 150 machines: A Burroughs Comptometer, 27 Friden Calculators (10 banks), 8 Marchant Calculators (10 banks), 6 Monroe Calculators (8 banks), 59 Monroe Calculators (10 banks), 4 Remington Adding Machines and 45 Sunstrand Adding Machines. Until recently the following 19 machines of the International Business Machines Corporation were also in use; 1 type 405 Alphabetic Accounting Machine; 5 type 601 Automatic Multiplying Machines; 2 type 077 Collators; 3 type 80 Horizontal Sorters; 6 type 15 Motor Drive Punch Machines; 1 type 5B Automatic Reproducing Punch and 1 type 513 Reproducing Summary Punch. Surely never before has such an extensive scientific computing laboratory been established. It is kept working to fullest capacity by confidential demands of the Army and Navy, and by many approved requests of scientists. Brief indications may be given of *A*. Tables already published; *B*. Tables in process of reproduction; *C*. Tables for which manuscripts are completed; *D*. Tables for which computations are completed; and *E*. Tables for which computations are in progress.

A. The following 12 large volumes ($8\frac{1}{2}$ x 11 ins.), strongly bound in buckram, are sold at two dollars each:

1. Tables of the Exponential Function e^x, 1939, 535 p.
2. Tables of Sines and Cosines for Radian Arguments, 1940, 275 p.
3. Tables of Circular and Hyperbolic Sines and Cosines for Radian Arguments, 1940, 405 p.

4–5. Tables of Probability Functions $\frac{2}{\sqrt{\pi}}e^{-x^2}$, $\frac{1}{\sqrt{2\pi}}e^{-x2/2}$, $\frac{2}{\sqrt{\pi}}\int_0^x e^{-t2}dt$, $\frac{1}{\sqrt{2\pi}}\int_{-x}^x e^{-t2/2}dt$, 2v., 1941–42, 696 p.

6–8. Tables of Sine, Cosine, and Exponential Integrals, 1940–42, 3v., 673 p.

9–12. Table of Natural Logarithms, 4v., 1941–42, 2009 p.

There are also (among others)

13. Table of the first ten Powers of Integers from 1 to 1000, 1939, 80 p. ($8\frac{1}{2} \times 13\frac{1}{4}$ ins.)

and the important

14. Table of Lagrangean Interpolation Coefficients, prepared for the Ordnance Department in June, 1941, 50 p. ($8 \times 10\frac{1}{2}$ ins.), but only recently released for more general distribution by Dr. Briggs.

B. Among tables in process of reproduction are:

1. Table of the Electronic Functions $G = 1/(1-\beta^2)^{\frac{1}{2}}$, $v = (m_0c^2/e)(G-1)$ and $H\rho = [(m_0c)/e](B_G)$;
2. Table of Arctan x;
3. Table of the Bessel Functions $J_0(z)$ and $J_1(z)$ for Complex Arguments $z = \rho e^{i\phi}$;
4. Miscellaneous Hydraulic Tables.

C. Manuscripts have been completed for the following tables:

1. Table of the Associated Legendre Functions $P_n^m(x)$ and $Q_n^m(x)$, for arguments x and ix;
2. Table of fractional powers a^x and x^a;
3. Table of $\int_0^x J_0(t)dt$ and $\int_0^x Y_0(t)dt$;
4. Tables of Tan x, Tanh x, Cot x and Coth x [0(.0001)2];
5. Tables of the Definite Integrals

$$A(k, n) = \int_0^1 x^k \sin(n\pi x)dx, \quad B(k, n) = \int_0^1 x^k \cos(n\pi x)dx, \quad k = 0, 1, 2 \cdots; \quad n = 1, 2 \cdots, 100;$$

D. There are also three important tables for which computations are completed:

1. Table of the Bessel Functions $J_\nu(x)$ and $I_\nu(x)$;
2. Table of $Q_n(x) = \sqrt{\frac{\pi}{2x}}\, J_{n+\frac{1}{2}}(x)$;
3. Table of Reciprocals of the integers from 100,000 to 200,000.

E. Then there are the following six equally important tables for which computations are in progress:

1. Table of Bessel Functions $Y_0(z)$ and $Y_1(z)$ for complex arguments;
2. Tables of Lagrangean Interpolants, Orders three to eleven;
3. Tables of the Complete Elliptic Integrals K of the First Kind, the Nome $q = \exp(-\pi K'/K)$, and the Elliptic Functions am u, sn u, cn u, dn u, for real and imaginary arguments;
4. Tables of the Chebyshev Polynomials $C_n(x)$ and $S_n(x)$, $n = 1, 2, \cdots, 12$;
5. Table of the first ten Powers of the Reciprocals of the Integers from 1 to 1000;
6. Table of Inverse Circular and Hyperbolic Functions other than arctan x (see B.2).

Scientists must regard the calculation of even such a body of important tables as an extraordinarily impressive achievement, for the time that the Project has been in existence. But appreciably more has been done than is here suggested, since no listing of con-

fidential tables for the Army and Navy is permitted. Furthermore, the preparation of all such tables was begun by Dr. Briggs after having in consultation with many experts verified their great value in pursuits of scientific research. The endless requirements of the war effort have only intensified the demand for these and for many other tables. Yet what do we find in connection with the present organization of the Project? It may be years before these 12 completed tables listed in B, C and D are published.

Surely, then, there is here vital need for action, to the end that means be sought for the rapid publication, not only of all the above-mentioned tables, but also of all later tables completed by the Project. There must be many mathematicians and mathematical physicists, who would be willing to join with me in most earnestly commending this matter to the attention of Dr. Briggs.

RAYMOND CLARE ARCHIBALD

BROWN UNIVERSITY,
August, 1942.

STANDARDIZED PLANT NAMES

THE second edition of this work has recently appeared and has been given several brief favorable reviews by individuals who apparently have not gone over it critically from the botanical standpoint. Originally prepared for standardizing Latin and common names for nurserymen and horticulturists the Latin names printed in bold face in the first edition were sometimes compromise names that followed no recognized botanical code, but were followed by the code name in italics, lest too many changes from nursery use would not be acceptable. The result was that these names were not acceptable to botanists and the principal author did not use them in his official publications. The Latin names in the new edition conform, with but very few errors, to the now generally recognized International Botanical Code and under any code occasional changes in names will occur as types are studied and botanists and horticulturists will always have differences of opinion as to the limits of species and genera.

Nurserymen had reason to believe that at least the common names in the first edition would become fairly permanent, yet the present authors have indulged in changes of many common names that would compare well with the vagaries of the most extreme taxonomists and produced many caconyms that will be acceptable neither to botanists nor horticulturists. Common names are fixed by local usage, though not always consistently, and the best of the common names recognized by the standard manuals of botany will continue to be used in future editions and by the far greater number of manual users.

While it has been impossible to make a complete list of exceptions they mostly fall into two groups, *viz.:* two-word combinations of illogical common names and two-word combinations of a common and a Latin name that are exceedingly offensive to most botanists and other users of plant names. Thus far over 100 such names have been discovered in the new edition and additions are turning up frequently. A few examples will suffice.

Page	Edition I.	Page	Edition II.
	Group I		
19	Dragonroot	22	Dragonroot Jackinthepulpit
158	Wintergreen	271	Checkerberry Wintergreen
267	Common toadflax	301	Butter-and-eggs Toadflax
285	Muskplant	301	Muskplant Monkeyflower
388	Kudzu-bean	505	Thunberg Kudzubean
	Group II		
60	Nickernut	78	Nickernut Caesalpinia
91	Leatherflower	131	Leatherflower Clematis
185	Farewell-to-spring	276	Farewell-to-spring Godetia
255	Mountain-laurel	319	Mountainlaurel Kalmia
283	Cucumber-root	382	Cucumberroot Medeola

Other long-accepted common names are changed in one word form. Faunlily is applied to the whole genus *Erythronium,* though Troutlily was previously used. It is illogical to apply the prefix Fawn to the species that are white and purple. The western white species is usually called Glacier or Avalanche lily. *Trillium grandiflorum,* commonly called large-flowered Trillium, is erroneously called Snow Trillium, as in the first edition. *Trillium niveum* (niveum meaning snow) is correctly the Snow Trillium. California poppy is changed to Goldpoppy. Bluebonnet is applied to *Lupinus texensis* and Texas lupine to *Lupinus subcarnosus.* These common names should be reversed, as Bluebonnet is officially applied to *Lupinus subcarnosus* in its legal designation as the state flower, but the lay element does not distinguish the species and applies Bluebonnet to both, though perhaps *L. texensis* is the more abundant of the two. Oregon Hollygrape is changed back to Oregongrape.

The use of hyphens is largely, though often illogically, eliminated, but Butter-and-eggs and Farewell-to-spring would also suggest the preferable use of Jack-in-the-pulpit instead of Jackinthepulpit.

The District of Columbia floral emblem, American Beauty Rose, adopted by the Commissioners in 1925, is omitted on page 596 and the dates of official designation of the floral emblem of 15 states are omitted.

A summary of all the items listed shows that of its 675 pages, 73 pages or about 10.8 per cent. have at least 151 omissions or items to which exception will be taken by most botanists, and these do not begin to represent all the additional exceptions found or likely to be found by other botanists. Forty-four of the pages have only one item each, 11–2, 7–3, 3–4, 2–5,

1-7, 1-12 and 1 page 18 items. However, the 151 items listed constitute only 1 in every 596 of the about 90,000 names in the book, not including the cross references.

It is hoped that eventually a complete list of the generally approved changes and few errors and omissions can be made available to those interested.

Standardized Plant Names, second edition, edited by Harlan P. Kelsey and William A. Dayton, Harrisburg, Pa., J. Horace McFarland Co., 1942. Price, $10.50.

P. L. RICKER
THE WILD FLOWER PRESERVATION SOCIETY

STUDENTS' LECTURE NOTES

NINETY-NINE per cent. of my students in physiology courses given in Europe, China and in Chicago have been writing down the lectures so arduously that they did not have much opportunity either to think or to grasp the significance and relations of the subject. Very few of the students have had the time to go over the lecture notes at home and to correct them and make additions. During my own studies I have found it more profitable to listen intently to the lecturer, to take a few notes about the subjects discussed and to work out the lectures at home. Or, in the case of lecturers who use books, to find out the book and read the chapter at home. I have found very few students who could not remember lectures without having written them down in detail. I feel that the student who tries to write the lecture in the classroom loses more than he can gain, because by the writing he suppresses his critical thinking, the establishment of relationships between different matters and, worst of all, gives himself no training for remembering and associating the spoken word.

I have, therefore, for a number of years adopted the following system which has been successful enough to be made known for the trial and use in other institutions: One student or two, according to the size of the class, is asked to take lecture notes and to elaborate them at home into a well-written and well-correlated paper. The rest of the class is asked not to take notes, but to listen to the lecture critically and to discuss the subject or to ask questions during the last five to ten minutes of the lecture period. The reports of the students are then corrected and amplified by myself, and the pertinent literature is added. The secretary of the class receives this copy and has mimeographic copies made by the secretary of the department. The total cost to the student of these copies for a course of one quarter, two lectures a week, is approximately $1.40. The students have welcomed this method and have made good use of it, as I have been told by a great number of them. They feel that they learn more when they do not write constantly, and they are apparently under less nervous and physical strain than when they would have to watch for every word and sentence.

The reports handed in by the students are used as term papers and are corrected, the final grade of the student depending on the quality of these papers and his understanding and knowledge shown during the discussions at the end of each lecture. In a large class, each student will submit only one paper in a quarter, while in a smaller class he may have to submit two or three papers. If the one paper of a student of a larger class is not satisfactory, he is asked to submit another one. I have found this way of grading students as good as that which is achieved by a final oral or written examination at the end of the quarter. The students have the added advantage that at the end of a quarter they own the corrected and rounded out lecture notes, with the most important references from the literature for future reference, and the lecturer himself has the advantage of having his course worked out and organized so that he can use it again with the addition of recent advances or with slight reorganizations.

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SCIENTIFIC BOOKS

RECENT MEDICAL BIOGRAPHIES AND AUTOBIOGRAPHIES

Four Treatises of Theophrastus von Hohenheim called Paracelsus. Translated from the original German, with Introductory Essays by C. Lillian Temkin, George Rosen, Gregory Zilboorg, Henry E. Sigerist. Edited with a Preface by Henry E. Sigerist. Baltimore: The Johns Hopkins Press. xii + 256 pp., with frontispiece. 1941. $3.75.

Torch and Crucible: The Life and Death of Antoine Lavoisier. By SIDNEY J. FRENCH. ix + 285 pp. Princeton University Press. 1941. $3.50.

Dr. Bard of Hyde Park: The Famous Physician of Revolutionary Times. The Man Who Saved Washington's Life. By JOHN BRETT LANGSTAFF. Introduction by Nicholas Murray Butler. 365 pp., with frontispiece, and 11 illustrations. New York: E. P. Dutton and Company. 1942. $3.75.

Death Loses A Pair of Wings: The Epic of William Gorgas and The Conquest of Yellow Fever. By ROBIN LAMPSON. xii + 518 pp. New York: Charles Scribner's Sons. 1939. $3.00.

William Henry Welch and The Heroic Age of American Medicine. By SIMON FLEXNER and JAMES THOMAS

FLEXNER. x + 539 pp., with frontispiece and 25 illustrations. New York: The Viking Press. 1941. $3.75.

The Doctors Mayo. By HELEN CLAPESATTLE, with a foreword by Guy Stanton Ford, President of the University of Minnesota. xiv + 822 pp., with 65 illustrations. Minneapolis: The University of Minnesota Press. 1941. $3.75.

A Surgeon's Life: The Autobiography of J. M. T. Finney. xiv + 396 pp., with frontispiece. New York: G. P. Putnam's Sons. 1940. $3.00.

A Yankee Doctor in Paradise. By S. M. LAMBERT, M.D. x + 393 pp., with frontispiece. Boston: Little, Brown and Company. 1941. $3.00.

The Man Who Lived for Tomorrow: A Biography of William Hallock Park, M.D. By WADE W. OLIVER. 507 pp., with frontispiece. New York: E. P. Dutton and Company, Inc. 1941. $3.75.

Time and the Physician: The Autobiography of Lewellys F. Barker. viii + 350 pp., with frontispiece and 6 illustrations. New York: G. P. Putnam's Sons. 1942. $3.50.

L. Emmett Holt: Pioneer of a Children's Century. By R. L. DUFFUS and L. EMMETT HOLT, JR. Foreword by Edwards A. Peck, M.D. xiv + 295 pp., with frontispiece. New York: D. Appleton-Century Company, Inc. 1940. $3.00.

Hugh Young: A Surgeon's Autobiography. xiii + 554 pp., with frontispiece, 103 anatomical drawings, and other illustrations. New York: Harcourt, Brace and Company. 1940. $5.00.

As I Remember Him: The Biography of R. S. By HANS ZINSSER. ix + 443 pp. Boston: Little, Brown and Company. 1940. $2.75.

EXCEPT for subjects dead for several centuries, biographies are usually inspired apologies. In the case of autobiographies, this apologetic tendency may become almost psychiatric, at least in the case of physicians. The anguished human conscience of the egocentric crusader, such as Hugh Young, appears in his: "There is still so much to do, and so much to live for." The apology of the shy introverted humanistic scientist is stated by Hans Zinsser, speaking of himself: "R. S. was really quite an ordinary person about whom it was hardly worthwhile to write a book. . . . At the time of his death he was as thoroughly bewildered as any thoughtful individual of our time is bound to be."

None of the biographies here noticed have the detailed delineation (or dullness) of such a recent classic as Harvey Cushing's "Life of Sir William Osler" (2 volumes, Oxford, 1925). The autobiographies are written too self-consciously to be honest. These biographies and autobiographies, therefore, are slightly disappointing, like all such efforts must be, to those who know the subjects. They are all, however, interesting and significant in showing the power of current American medical genius.

Not accidentally were the books on Lavoisier and Paracelsus included among these characteristic volumes. Both men were intellectual heretics in their time. Both exemplify that independent tendency of American medicine, which, repudiating the past which once inspired it, points the way to new practical achievement.

It may seem peculiar to consider a series of annotated translations of the writings of Paracelsus as a "biography." After four centuries, however, a man appears more clearly from his own words than from any account a formal biography might give. The common clay of humanity lies naked and unashamed in his "Reply to Certain Calumniations of His Enemies." His environmental conditioning is apparent in his "Book on Nymphs, Sylphs, Pygmies, Salamanders and on the Other Spirits." His skill in clinical observation and prescription and his courage in probing for a rational understanding of obscure abnormalities is apparent in his writing: "On the Minor Sickness and Other Diseases and The Diseases That Deprive Man of His Reason, Such as St. Vitus Dance, Falling Sickness, Melancholy, and Insanity, and Their Correct Treatment." In publishing this book, Professor Sigerist's wish is accomplished—to revive "the personality of an honest man who was a great physician and a staunch fighter for what he considered the truth. It is so easy to be orthodox and to reap honors by repeating what people expect and wish to hear. Progress, however, is achieved through a clash of ideals, and heretics like Paracelsus are a ferment without which there would be no life."

While Professor French's account of Lavoisier necessarily relies on Grimaux's standard biography, it breaks new ground in appraising the scientific achievements of Lavoisier. While Lavoisier's scientific dependence on Priestley and Cavendish is carefully described, he is depicted as the leading scientific organizer for his century, not only in chemistry, but also in physiology, biology and sociology. An interesting detail is the discussion of the relationship between Lavoisier and the du Ponts.

Although European medicine was firmly established in the sixteenth century by the Spanish in Mexico, and in the seventeenth century by the French in Canada, English medicine did not develop until the eighteenth century in the American colonies. Philadelphia and New York vied with each other in the quality of their medical service, and in the establishment of hospitals and training centers. Most of the early leaders of American medicine studied in Edinburgh and London. After returning from these centers, Samuel Bard (1742–1821) promoted the New York Medical School, which is now the College of Physicians and Surgeons of Columbia University, assisted in the founding of the famous New York

Hospital, developed Hyde Park, and with his pupil David Hosack (1769–1835) established the Elgin Botanical Gardens, where Rockefeller Center now stands. Bard and Hosack were notable examples of the public-spirited American physicians of the late eighteenth and early nineteenth centuries, and their influence did much to shape the practical course of subsequent American medicine.

Robin Lampson has attempted something new in biography. Although this remarkable "novel in cadence" was published three years ago, a review of it is still pertinent, since the work seems to be so little appreciated by scientists. It is an extremely accurate analysis of the achievement of William Gorgas in applying available scientific knowledge to the public health control of yellow fever. Lampson's effort is an extraordinary union of sound science with high artistic skill. Since many scientists fail to realize the intellectual aspects of serious artistic effort, and particularly since most scientists are not interested in literary innovations, this remarkable book has been neglected by the very ones who might profit most from it. The story is told only to 1903, but an appended chronology carries Gorgas's life to his death in 1920. The care with which Lampson compiled his material is indicated by his extensive acknowledgments, particularly to important and frequently forgotten literary sources.

Perhaps the most important book of the biographies here surveyed is Simon and James Flexners's "William Henry Welch." The sub-title, "The Heroic Age of American Medicine," implies a rather peculiar judgment. This fine achievement of the Flexners is a quite successful attempt to combine a definitive biography, which by itself is apt to be dull, with a popularization and interpretation, which alone is apt to be exaggerated for effect. Copious notes indicate the vast material used by the Flexners in preparing this very readable account of their hero. Mostly, of course, it is eulogistic. This is appropriate, since Welch's scientific achievements in bacteriology and pathology are outstanding, and his successful applications of his knowledge to social problems involving public acceptance of public health measures are extremely significant. Those familiar with the development of American medicine during the past half-century have suspected much of the wise behind-the-scenes manipulations of Welch. Unfortunately, hero-worship tends to minimize obvious faults. Welch himself would have been among the first to acknowledge them, because he was genuinely honest and human. A serious error in judgment for which Welch was responsible, for example, was the unfortunate division of medical schools such as those at Harvard, Washington University at St. Louis and Johns Hopkins at Baltimore, from the main university campus. On the other hand, we have by no means approached Welch's high scientific and humane idealism, as witness the contrast between our present anonymous censorial control of scientific reporting and Welch's influence in preventing such conditions in 1917. We need Welch's wise counsel. Fortunately it is available in the many examples described so well by the Flexners.

The practical character of American medicine is remarkably exemplified by William J. (1861–1939) and Charles Mayo (1865–1939). Following faithfully in the pioneer footsteps of their physician father, the famous brothers made their clinic in Rochester, Minnesota, a world center for surgical achievement and medical research and training. Their amazingly active career and their extraordinary success is detailed with skill in this well-illustrated and thoroughly documented volume. The solid achievement of the Mayos remains, without inviting thus far the "debunking" that often follows excessive eulogistic publicity.

The recent untimely death of Dr. J. M. T. Finney, for so long professor of surgery at Johns Hopkins, brings his autobiography into bold relief. Dr. Finney was born in 1863 on a Mississippi plantation, was educated at Princeton and Harvard Medical School, and promptly became one of the outstanding Hopkins surgeons. He describes clearly his important services during the last war, and gives particularly entertaining accounts of his professional colleagues. Remarkable was his refusal of the presidency of Princeton.

One of the most interesting of recent medical autobiographies is Dr. Lambert's account of his long service with the International Health Board in New Guinea, the Solomon Islands, Fiji, and all the fascinating South Pacific potential paradises. The book is brilliantly written and contains an extraordinary amount of general scientific information bearing on anthropology, sociology, geography and geology, preventive medicine, chemotherapy and zoology. There are interesting accounts of the many scientific expeditions which have studied in the South Seas during the past quarter of a century. Impressive is the practical achievement in tremendous reduction in preventable diseases and in the death-rate through the South Pacific area as a result of the application of modern scientific information. Significant are Dr. Lambert's many wise observations on the character of the people. The book should be carefully studied, particularly at this time by all who are interested in the problem we are facing in the Pacific.

Like so many other leaders of American medicine, William H. Park (1863–1938) devoted his career to the applications of bacteriology, immunology and epidemiology, to the prevention of disease generally,

and to the promotion of public health. Park's great achievement was the establishment of the highly efficient public health service for the world's greatest city. The details of his career show why he was cited as "the perfect type of a scientist in the service of the state."

Among the many brilliant leaders who made the Johns Hopkins Medical School so great is Lewellys F. Barker, a Canadian Quaker, who studied in Toronto and Europe, served in the Philippines and in India, and succeeded Osler as head of the Department of Medicine at Hopkins. Later he gave up his full-time university work to engage more in practice and public work of a broad social nature.

The development of pediatrics has been one of the outstanding achievements of modern medicine. An American pioneer and influential leader in this was Luther Emmett Holt (1855–1924). Most of Holt's career was spent in New York City, although he traveled extensively and participated in professional work in Europe and China, after World War I. Like most leaders in American medicine, Holt was a prodigious writer, and his texts relating to his specialty have been standard in medical literature for years.

Hugh Hampton Young's autobiography is vigorous and entertaining. It paints an astonishing picture of contrast between serious citizenry, merry-making buffoonery and careful meticulous technique in surgery. The volume is unusual in containing a considerable amount of technical material relating particularly to the study of urology, which Dr. Young has been so instrumental in promoting. There are intriguing chapters on World War I medicine, Diamond Jim Brady, excursions of all sorts to all parts of the world, and a remarkable series of pen pictures of his many brilliant associates at Hopkins. It also contains the story of mercurochrome, but not quite complete.

Hans Zinsser's remarkable autobiography is a brave and brilliant apology for modern culture. His religious and romantic impressions are sensitive poetry; his anecdotes are delightful; his descriptions of his professional work, particularly in Serbia, Russia, Tunis and the Orient, emphasize the political difficulties of applying modern knowledge to human welfare, and through it all his philosophical confusion resolves into a long-range optimism which even impending death can not dispel.

Significant as a group is this baker's dozen of recent biographies and autobiographies relating to medical leaders. They indicate the dependence of American medical science on its European sources—a dependence melting now into a common pool of scientific achievement with our English colleagues. Whereas American medicine stems from sturdy Scotch and English roots, it has been abundantly grafted with French and German buddings. Many of these are now being trimmed away. It remains to be seen whether the stock will be able to carry the heavy potentialities of Russian or Chinese or Latin-American medical ideas which are certain to flourish among us if given a chance.

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SPECIAL ARTICLES

HEPARIN AND THE ANTITHROMBIC ACTIVITY OF PLASMA[1]

THE antithrombin of plasma destroys thrombin almost as rapidly as the latter is formed. Eventually, the serum, expressed from the clot, is found to contain merely traces of prothrombin and thrombin.

On adding heparin to plasma, the antithrombic activity is known to be "increased." We shall show, however, that heparin does not increase the total capacity of plasma to destroy thrombin; it merely increases the speed with which it does so. The heparin thus appears to behave merely as a catalyst in the destruction of thrombin.

Fig. 1 illustrates the relationships which were found. Into each of 4 tubes were placed 3,880 units of purified thrombin. To one (A) was added heparin alone, to another (B) was added plasma, to a third (C) and a fourth (D) were added both heparin and plasma. All tubes were made up to constant volume and were then allowed to stand for an hour. During that time the thrombin concentration was repeatedly measured. The heparin alone (Curve A) had no effect. The most striking change was shown by the tube (D), containing plasma, together with 0.5 Toronto units of heparin. Here the thrombin titer fell precipitously to the 1,500-unit level within a minute. It then remained at that level throughout the course of the experiment. With only 0.1 unit of heparin (curve C) the thrombin titer also fell to the 1,500-unit level, but 15 minutes were required instead of one.

From these experiments it is evident that the amount of co-factor determines the amount of thrombin destroyed; the amount of heparin determines the *speed* of destruction.

[1] This work was aided by a grant from the John and Mary R. Markle Foundation. Funds for a technical assistant were also supplied by the Graduate College, State University of Iowa.

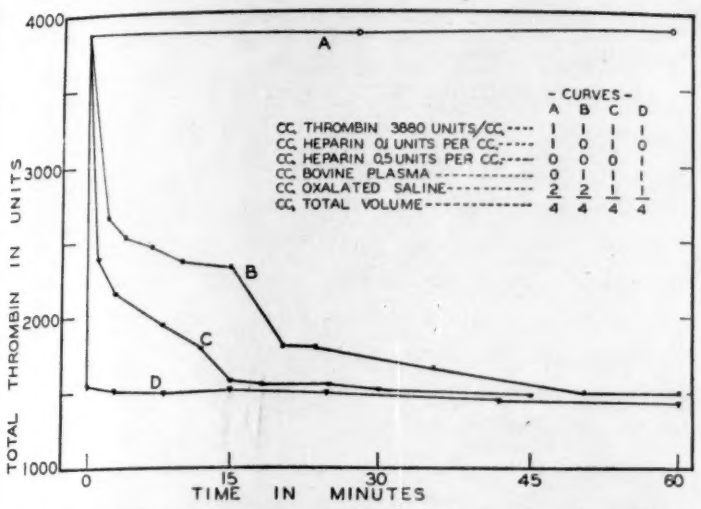

FIG. 1. The thrombin and the heparin were dissolved in oxalated saline (0.075 per cent. $K_2C_2O_4$ + 0.80 per cent. NaCl). Oxalated bovine plasma was obtained from a mixture of 7 parts blood and 1 part 1.85 per cent. $K_2C_2O_4$. The thrombin unit is the amount required to clot 1 cc of purified fibrinogen solution, containing calcium and acacia, in 15 seconds. In these experiments, calcium was omitted in order to avoid forming thrombin from the prothrombin present in the oxalated plasma. Under these conditions (*Am. Jour. Physiol.*—in press), thrombin is one third less efficient; the thrombin titers were therefore multiplied by the factor, 1.5, and the results were then plotted in terms of standard units.

In light of these findings, it is of great interest that plasma alone, without a supplement of heparin, also caused the thrombin titer to fall to the 1,500-unit level (tube B). The fall occurred quite slowly, however—almost an hour was required. It is known that plasma contains small amounts of heparin, and this heparin may be an essential catalyst, without which the reaction can not occur in finite time. It will be necessary to isolate the co-factor in order to determine whether, in the absence of heparin, it possesses any detectable antithrombic activity. It may well be that it does not.

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THE ULTRAVIOLET SPECTROGRAPHIC EXAMINATION OF THE FAT FRACTION OF MOUSE MILK AND MAMMARY GLANDS[1]

THE presence of a mammary tumor-producing substance in the milk of high tumor strain mice has been adequately demonstrated by Bittner,[2] Andervont,[3] DeOme.[4] It is known to be present also in the blood and certain tissues of high tumor strain females.[5,6] If this factor is similar to the estrogens or known synthetic carcinogenic hydrocarbons, it should be demonstrable by a comparison of the ultraviolet absorption spectra of the fat fractions of the milk and the mammary glands of high and low tumor strain mice. Milk and non-tumorous mammary glands from lactating high tumor strains, A, C3H and dba and from the low tumor strain C57Black were studied.

Milk was obtained by means of a miniature milking machine. Only mammary glands engorged with milk were used. Freshly excised mammary glands were plunged into liquid air and macerated with CO_2 as described by Strait and Aird.[7] The macerate was extracted by a solvent-separation procedure involving the use of acetone, ether, alcohol and isooctane. Alcohol soluble and insoluble fractions were studied independently. Preliminary control experiments indicated that extreme care is necessary in the use and purification of solvents if spurious results are to be avoided. The extraction procedure permitted study of the ultraviolet region down to 2300 Å, a range sufficient to include compounds of the type expected. Five samples of milk from A and C57Black mice averaging 3.26 g and eleven samples of mammary glands averaging 3.62 g were used. The absorption spectra of the extracts in spectroscopically pure isooctane were photographed in the ultraviolet with a Hilger medium quartz spectrograph. The extraction procedure is known to recover 1, 2, 5, 6-dibenzanthracene and the estrogens triphenylethylene and oestradiol.

A comparison of the ultraviolet absorption spectra of milk and mammary glands of high and low tumor strain mice showed no significant differences. These results would indicate that (1) the milk-borne factor either is not carried in the fat fraction or, if it is (2) it is not spectrographically similar to the carcinogenic hydrocarbons or estrogens, or (3) it is present in quantities too small to be detected spectrographically. Triphenylethylene may be detected in concentrations of 0.025 milligrams per gram, the naturally occurring estrogens in somewhat higher concentrations, and the carcinogenic hydrocarbons in lower concentrations.

Since the initiation of these experiments, recently published ultracentrifugation data[8] have indicated also that the active agent is primarily in the non-fat fraction. Ultrafiltration experiments by one of us on

[1] This work was in part supported by a grant in aid from the Blanche and Frank Wolf Foundation. The authors wish to express their appreciation to Dr. I. H. Perry for her valuable counsel.

[2] J. J. Bittner, *Jour. Nat. Cancer Inst.*, 1: 155, 1940.

[3] H. B. Andervont, *Jour. Nat. Cancer Inst.*, 1: 147, 1940.

[4] K. B. DeOme, *Am. Jour. Cancer*, 40: 231, 1940.

[5] J. J. Bittner, *Pub. Health Rep.*, 54: 1827, 1939.

[6] G. W. Woolley, L. W. Law, C. C. Little, *Cancer Res.*, 1: 955, 1941.

[7] L. A. Strait, R. B. Aird, S. Weiss, *Jour. Pharm. Exp. Therap.*, 73: 363, 1941.

[8] M. B. Visscher, R. G. Green, J. J. Bittner, *Proc. Soc. Exp. Biol. and Med.*, 49: 94, 1942.

the non-fat portions of milk and mammary tissues are now in progress.

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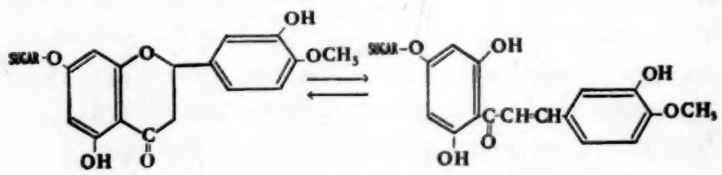
THE ISOLATION OF A NEW OXIDATION-REDUCTION ENZYME FROM LEMON PEEL (VITAMIN P)[1]

SZENT-GYÖRGYI and collaborators in 1936[2] postulated the existence in lemon peel of a new vitamin, designated the permeability vitamin or P, concerned with the regulation of capillary permeability and fragility. Since then much experimental and clinical work has been carried out with crude preparations indicating the presence of factors influencing the capillary state, the blood pressure and related phenomena. It was the purpose of the present work to isolate in pure form the capillary or vitamin factor.

Vitamin P was believed by Szent-Györgyi[3] to be citrin, a mixture of the flavanone glycosides, hesperidin and eriodictin. We initially prepared citrin by a method similar to that of Szent-Györgyi, which consisted in extraction of the ground lemon peel with acetone, precipitation with $Ba(OH)_2$, and liberation of the pigment with H_2SO_4 in a small volume of methanol. On standing for several days a white precipitate of hesperidin slowly separated out, accompanied by the bleaching of the solution. This observation, along with others in the course of the work, led us to regard the yellow eriodictin of Szent-Györgyi as the chalcone of hesperidin. This explains the difficulty encountered by Szent-Györgyi in separating hesperidin from his yellow material, inasmuch as there is an equilibrium between the flavanone and its open chalcone isomer:



hesperidin (flavanone glycoside) — hesperidin chalcone (3,2′,4′,6′-tetrahydroxy, 4-methoxy-chalcone glycoside)

This equilibrium is shifted to the right in alkaline medium and to the left in acid medium. It has been previously observed[4, 5] that the 2′-hydroxy-chalcones exhibit a marked tendency to isomerize to the corresponding flavanones.

The pure chalcone was prepared by dissolving several-times recrystallized hesperidin in cold alkaline solution with subsequent neutralization, upon which the chalcone rapidly crystallized and was filtered, washed with acetone and ether and dried. This crystallization is immediate, whereas the ring-closure proceeds at a much slower rate. The chalcone was obtained in the form of bright yellow microscopic crystals of melting point 251–252° C. (uncorr.), soluble in pyridine, very slightly soluble in methanol and insoluble in water. The chalcone could easily be reverted to hesperidin when suspended in absolute methanol (traces of anhydrous HCl increased the rate of this reaction), and the resulting product gave no depression of the melting point of the original hesperidin (261–262° C.).

An active group such as occurs in the chalcone (—CO—CH=CH—) should be easily susceptible to reduction. Upon solution of the chalcone in pyridine and treatment with small amounts of zinc and glacial acetic acid in an oxygen-free atmosphere, reduction took place rapidly as evidenced by the loss of color. Shaking the solution in air restored the yellow color. This chalcone is, therefore, a member of that class of naturally occurring substances capable of being reversibly oxidized and reduced.

Since most of these substances are associated with proteins as enzymes within the tissues a new method of isolation was developed in order to obtain the intact protein complex. An aqueous extract of lemon peel was saturated with $(NH_4)_2SO_4$ and the resulting precipitate filtered, redissolved, reprecipitated and dried *in vacuo*. This tan powder was exhaustively extracted in a Soxhlet with ether yielding a bright yellow solution and a pale tan residue. The ether-soluble pigment was shown by standard tests to be neither a carotenoid nor a benzopyrone type of pigment and will be the subject of further investigation in this laboratory. The protein residue was extracted with pyridine which served to split the pigment from the protein. This pigment was shown both by physical and chemical tests to be the chalcone of hesperidin. The denatured protein was repeatedly washed and found to give positive reactions to the standard protein tests.

When hesperidin opens to form the chalcone there is established an extensive system of conjugated double bonds, which greatly increases the absorption in the blue and near ultra-violet. Combination of the chalcone with the protein shifted the ultra-violet absorption maxima from 3320 Å. to 3270Å and from 3080 Å to 3020 Å without altering the shape of the curve. The chalcone forms complexes with other proteins, and it is probable that within the tissues it is

[1] One of us is indebted for a fund from the California Fruit Growers Association.

[2] L. Armentano, A. Bentsath, T. Beres, St. Rusznyak and A. Szent-Györgyi, *Dtsch. med. Wschr.*, 33: 1325, 1936.

[3] A. Szent-Györgyi, *Zeit. f. physiol. Chem.*, 255: 126, 1938.

[4] J. Shinoda and S. Sato, *Jour. Pharm. Soc. Japan*, 48: 791, 1928.

[5] A. Russell and S. Clark, *Jour. Am. Chem. Soc.*, 61: 2651, 1939.

kept in solution by such a mechanism. The chalcone-protein complex was found to be easily reduced by sodium hyposulfite and to be reoxidized by oxygen.

The chalcone-protein and its prosthetic group, hesperidin chalcone, can serve as hydrogen transporters in mammalian tissue. This was demonstrated in the l(+)-glutamic acid dehydrogenase system obtained from liver by the method of v. Euler, Adler, Günther and Das.[6] This system involves l(+)-glutamic acid, apodehydrogenase, codehydrogenase I or II and diaphorase; whether the chalcone is reduced by diaphorase or directly by the codehydrogenase we do not know at the present time. As previously mentioned, the chalcone is autoxidizable and, hence, under aerobic conditions can increase the oxygen consumption of such a respiratory system. Work is now in progress to determine the various respiratory systems in which the chalcone-protein may play a role and the exact location of this substance in the hydrogen transport chain. We believe that this material and perhaps similar substances play a part in tissue respiration of both plant and animal cells.

Finally, preliminary experiments have shown that the chalcone exerts a beneficial effect upon the state of the capillaries, decreasing the fragility and preventing localized hemorrhages.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN APPARATUS FOR CONTINUOUS FILTRATION IN BLOOD AND PLASMA TRANSFUSIONS

DESPITE the use of adequate amounts of anticoagulant, fibrin clots will form in stored blood or plasma. The amount of fibrin will increase with the time of storage, but may be present in blood shortly after it is drawn. The blood and plasma, therefore, must be filtered before administration to prevent embolism.

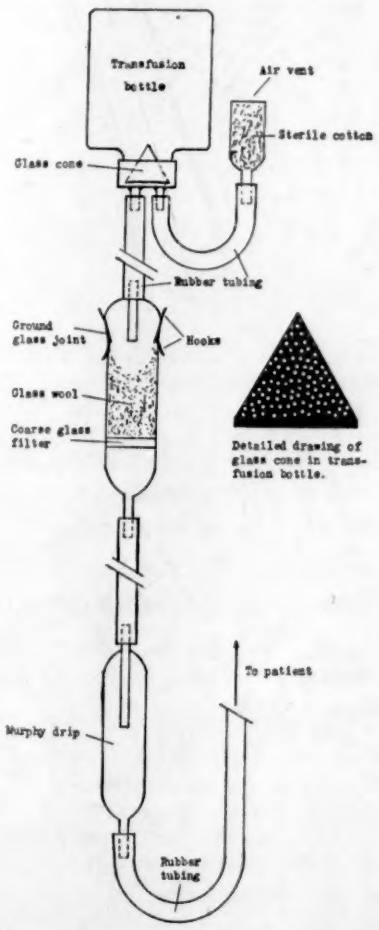

FIG. 1. Diagrammatic sketch of transfusion system, showing apparatus for continuous filtration.

In the methods employed at present, the most widely used materials are cotton gauze and metal screening. In many cases filtration through cotton gauze is carried out in the open air, permitting air contamination with bacteria. Furthermore, cotton gauze offers no uniformity for standardization, and no evaluation as to its pore size is possible. Metal screens, aside from the usual objection to metals for intravenous fluids, have been too coarse to retain all fibrin particles.

We have successfully used a filtering system which is fine enough to remove all fibrin particles. It consists first of a glass cone with coarse openings which holds back the large clots and prevents plugging of the rubber tubing. The blood is then filtered through glass wool (or glass cloth), and a fused glass filter which removes the remaining particles. "Pyrex" glass wool is adequate for this purpose, and, together with the fused glass filter, may be cleaned before use with cleaning fluid. The fused glass filter may be as fine as desired. It may retain the red cells or it may permit their easy passage. We have found that a filter made of fused glass particles, size 80 to 100 mesh, allows the rapid passage of the red cells and is still fine enough to hold back the fibrin particles.

The filtering apparatus permits administration in a closed system from the bottle into which the blood or plasma was drawn originally. This type of filter may be used to filter plasma in the field, either with the transfusion set as illustrated or by any other method. It satisfies the need for an adequate filter in the emergency treatment of shock with plasma.

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BIVALENT TYPHUS VACCINE OF HIGH IMMUNIZING VALUE

BASED on immunologic differences found between endemic and epidemic typhus strains, some authors recommend the production of "epidemic" vaccines as means of practical protection against the infection. Such vaccines have little if any value against "murine" and closely related strains which have been found to originate outbreaks of typhus fever of considerable extent and great severity. On the other hand, by increasing the antigenic content of our "murine" vaccine it is possible to immunize against both types of the infection as shown by Veintemillas,[1] who has found that complete protection can be obtained in men vaccinated against the experimental inoculation by both Mexican endemic virus and Bolivian epidemic typhus.

The results of practical vaccination with "murine" vaccine have not been carefully studied. A considerable number of persons has been vaccinated, but we may draw information from only 5,000. All these cases were potentially exposed to the infection and we know that at least seven developed typhus after being properly vaccinated. From a large group of physicians, nurses and medical students, two vaccinated persons developed mild typhus, while two non-vaccinated students died of the infection. The possibility that the indicated failures might have been due to insufficient cross-protection against some epidemic strains encouraged us to improve our monovalent "murine" vaccine by addition of "epidemic" antigen.

The cultivation of murine virus in the lungs of rats produces amounts of rickettsiae which are far superior to the yield of ordinary bacteria growing in artificial media if we compare lungs and media by weight, but, so far, we have not been able to obtain practical "lung" cultures of the "Breinl" strain, not even in mice. However, we have found that a Mexican epidemic strain is suitable for the production of considerable growth of rickettsiae in the lungs of mice. Pure suspensions of organisms thus obtained have a high protective value against both the "Breinl" and the homologous strains, although it is not satisfactory against endemic typhus. Suspensions which are water-like in appearance have a definite protective effect against the "Breinl" strain. The bivalent vaccine has a final concentration, when ready for human use, equivalent to a turbidity intermedial between Nos. 1 and 2 of the McFarland scale. This amount of antigen produces local and sometimes general reactions in vaccinated persons, but it is well tolerated. When tested in guinea-pigs, it shows a high degree of protection against both "murine" and "Breinl" strains. Since the organisms can be obtained in pure suspensions, the antigenic content of the vaccine can be modified at will. For instance, for field work we distribute a suspension containing 10 times more rickettsiae than that required for human vaccination. Therefore, 50 cc of such stock vaccine is sufficient to start the immunization of 1,000 people. Before use, the concentrated vaccine is diluted in the same syringe with 9 parts of steric isotonic NaCl solution administering a first dose of 0.5 cc and 2 subsequent doses of 1 cc each at weekly intervals. However, this treatment is insufficient for laboratory workers, who require at least 5 doses of vaccine to be fully protected.

The cost of production of the bivalent vaccine is relatively low since the mouse vaccine is only a minor part of the mixture.

In selecting the strain for the preparation of the murine vaccine we found the "L" strain most suitable for the production of large quantities of rickettsiae in the lungs of rats, and the epidemic strain called "42," which has properties equal to the "Breinl" strain, is readily adapted to grow in the lungs of mice. Further modifications in the antigenic composition of the vaccine depend on the results of its application to men.

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[1] F. Veintemillas, Suplementos del Instituto Nacional de Bacteriología, June and November, 1941, La Paz, Bolivia.

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